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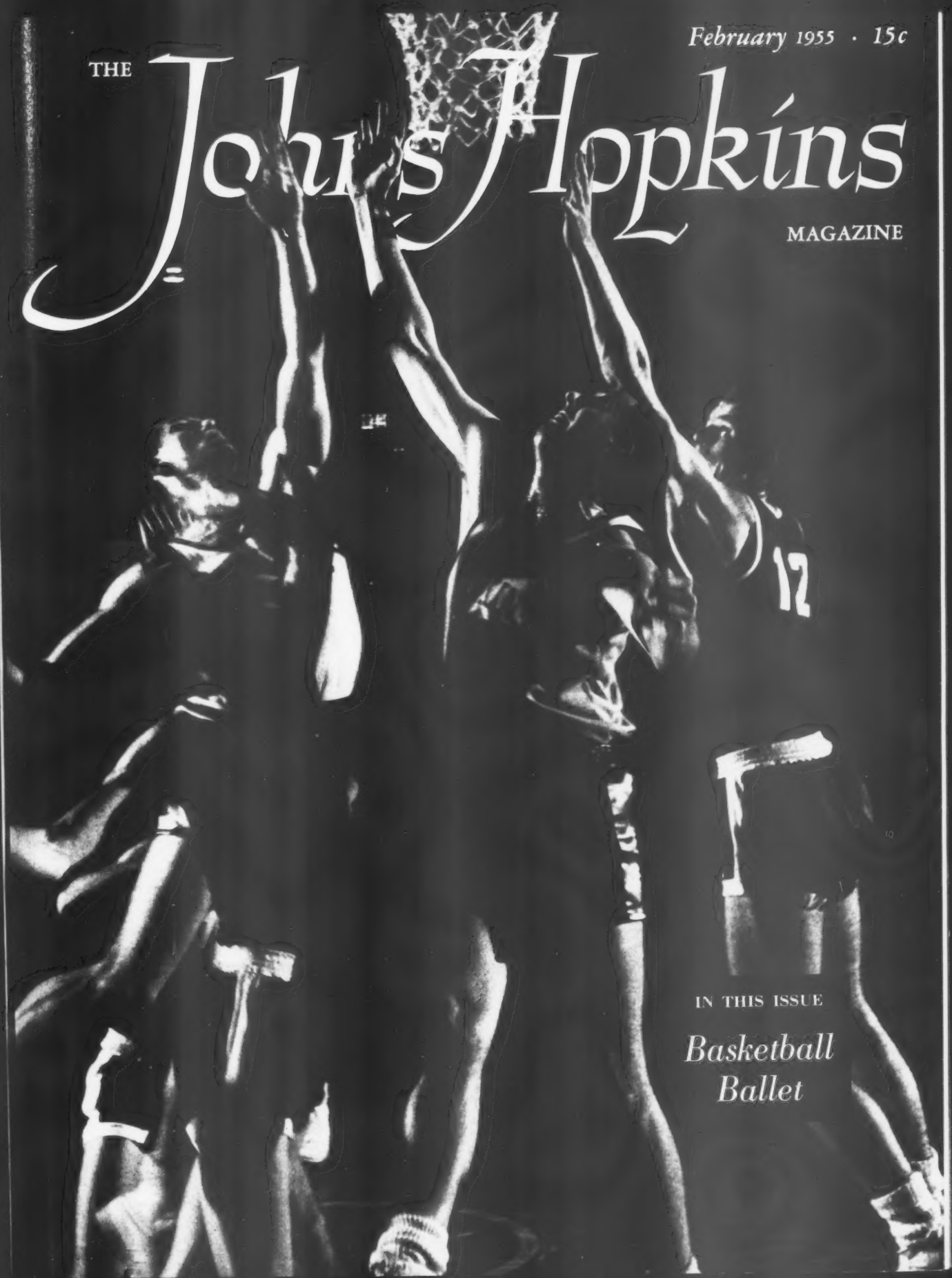
THE Johns Hopkins MAGAZINE

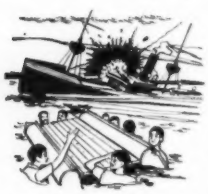


IN THIS ISSUE

Basketball Ballet

"¡Valiente!" cried the Spanish admiral

He cheered as his launch fished this man and seven more waterlogged American sailors out of Santiago Harbor, Cuba, on the morning of June 4, 1898. This was straining Spanish chivalry to the breaking point, for Richmond Hobson (right) and his little suicide crew had spent the previous night taking a ship into the harbor entrance under a hail of cannonade and deliberately sinking her to bottle up the Spanish fleet.



Hobson, who planned and supervised every detail of the operation, from placing the scuttling charges to dropping anchor under fire, was actually an engineer, not a line officer.

In Santiago Harbor, he led his first and only action against the enemy. But his cool-headed daring made him as much a hero of the day as Admiral Dewey. And proved again that America's most valuable product is Americans.

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THE Johns Hopkins MAGAZINE

VOLUME VI February, 1955 NUMBER 5

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Today, says the author, man stands on the verge of biological discoveries as revolutionary and potentially devastating as nuclear power. It will take all our wisdom, he says, to keep them in control.

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In the fall a group of students turns out in the gymnasium to compete for positions on the University's winter-sports teams. Here is the picture story of how a varsity basketball team came to be.

EVENTS OF THE MONTH: A HOPKINS CALENDAR ..... COVER III

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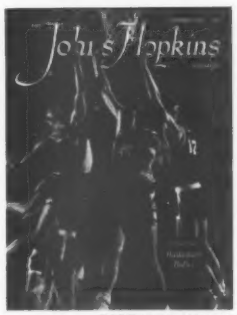
The Cover: This month's picture story tells of the development of a basketball team—specifically, the team that now represents the Johns Hopkins University in intercollegiate competition. Like most sports—and perhaps to a far greater degree than many—basketball abounds in fine situations for the photographer, whose camera's fast lens can freeze on film what the eye can never see: the moments of top action, the intense look of the player at the height of a scoring effort, the sidelights of humor that occur even when the pace of the game is fastest. The team's development is told in the article on page 6; the cover photo shows the climax.



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GENETICS

In The Service Of Man

By BENTLEY GLASS

HUMAN power, which mounted slowly indeed through the eons of prehistory and somewhat more rapidly after the advent of the sword and pen, has gathered momentum with logarithmic sweep since the dawn of modern science. Today it seems to be rocketing into outer space with the incredible energy of atomic fission.

I would be the last to imply that the principal value in the pursuit of scientific knowledge is the utilitarian one—that society should nurture science only because of its fruits. Yet the fruits are of undeniable importance, and before we eat, it might be well for us to see upon which side of the tree of good and evil they are borne. Power, especially unlimited power, can be more danger than blessing, and what foresight and intelligence we do possess ought to be exercised in safeguarding and channeling it into wise uses. Mankind was not prepared to use and control nuclear power. Today we stand on the verge of biological discoveries of an equally revolutionary and potentially devastating kind, which it will require all our wisdom to control. It is these eventualities which I wish to discuss.

A CENTURY ago, when my grandfather was born, the life expectancy of the average male infant was forty years. At the turn of the century, it was still only forty-eight years; but by 1930 it has jumped to fifty-nine years, and today stands at the amazing average of sixty-nine years. Whatever we may think about the wise use made of those extra twenty-nine years of life by the average American man, surely this achievement of medicine and biology has been spectacular.

Without recounting here the several steps in the advancement of health and longevity, I wish merely to point out that genetics has contributed its share to this progress. You are certainly aware of the tremendous role of penicillin in virtually wiping out many infectious diseases. In the course of the enormous wartime effort that went into the attempt to produce penicillin on a large scale, one serious difficulty was met.

The highest-yielding strains of the mold *Penicillium* would grow only on the surface of the culture medium in the great vats, and strains that grew well when submerged were poor penicillin producers. Applying the methods of inducing mutations already known to geneticists at the time, Milislav Demerec and his coworkers at the Cold Spring Harbor Laboratory of the Carnegie Institution of Washington undertook to irradiate with high doses of x-rays some *Penicillium* strains that grew well when submerged, and to look for mutations that would permanently affect the yield of penicillin. Among 504 selected products, one was found that doubled the production of penicillin over that in the original strain. This high-yielding strain became the basis of the enormous production of penicillin that within the last ten years has contributed so much to our national health.

Even more significant than the production of this strain, however valuable, was the insight gained in the studies by Demerec and others into the fluctuating relations between virulent, disease-causing bacteria and viruses and those agents that may be used to combat them. It was discovered that the infectious agents have powers of mutation too; and among the mutations that can be induced by x-rays or by chemical compounds, or among those that are always arising spontaneously in any large population of organisms, there are some mutations that confer resistance to the sulfonamide drugs, to penicillin, to streptomycin, in fact, to the killing effects of radiation itself. Learning this, geneticists at once made dire predictions about the consequences of an over-enthusiastic use of the wonder drugs and the antibiotics. But it seems that their medical colleagues failed to understand the danger, while the clamor of those who were ill led to the widespread use of such agents even for the common cold. Millions of doses were given to soldiers as mere prophylaxis, in the hope of warding off some possible infection. The result, now well known, was a near-disaster. People began to say, "The miracle drugs don't work any more. Penicillin has lost its punch. Streptomycin is no good." What had happened was exactly what the geneticists had predicted. Mutant strains of infectious germs had arisen that were now resistant to our drugs and antibiotics, just like

DR. GLASS IS PROFESSOR OF BIOLOGY AT THE JOHNS HOPKINS UNIVERSITY.

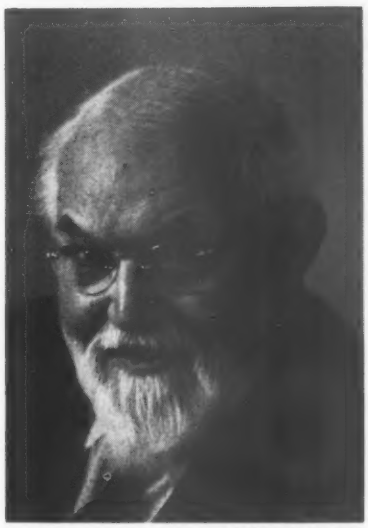
the now all-too-common houseflies that seem to thrive on DDT. As a matter of fact, there is in existence at least one bacterial strain that actually *requires* a supply of streptomycin in order to grow.

New kinds of antibiotics had then to be discovered and put into mass production. Yet the race was a losing one, for the mutational powers of the infectious organisms seem virtually unlimited and permit change far more rapidly than scientists can discover and produce new agents.

Here again the geneticist may interpose a prediction. The simultaneous coincidence of two mutations, say to penicillin resistance and to streptomycin resistance, is of an order of probability so low (about 10^{-16}) as to be truly negligible. Start out with two antibiotics to which the infectious agents have never been exposed, and use them together; and use a high enough initial dose to leave no survivors—except, of course, your patient. In this way the antibiotics may continue to serve mankind in the future. But meanwhile, penicillin and streptomycin must be given a rest.

In recent decades the shade of Malthus has once again risen to trouble us. Clearly, if the general life expectancy doubles, then even without any increase in births at all there are twice as many mouths to feed at any one time as there were before. But there are also more than twice as many adults with unmodified (or but slightly moderated) yearning to have children and rear families. The world population has soared, in spite of wars and famines, from one and a half billions of people, a century ago, to two and a half billions today. Fertile land is almost fully occupied. How can we feed another billion people, whom we may expect inevitably to arrive before the slowly dropping birth rate overtakes the still declining death rate? The immediate answer, if there be one, lies in the almost unheralded achievements of geneticists in increasing the food supply.

Last September 28 there died in Princeton, New Jersey, a geneticist who



ROBERT M. MOTTAR

George Harrison Shull

never received a Nobel prize or made a fortune. To most Americans George H. Shull remains completely unknown. Yet this man, together with a few others who made his theoretical achievement a practical possibility, has brought about a two-thirds increase in the United States yield-per-acre of the corn crop with no further requirement for labor, and has added literally billions of dollars to the income of our nation.

In fact, a true agricultural revolution, though scarcely recognized, has resulted from the discovery of hybrid corn. During the war years 1942–44, in the face of acute shortages of labor and of bad weather, and at a time when the corn acreage of the United States was still only about one-half planted with hybrid corn, the increased yield amounted to approximately fifty percent—a total of 1,800,000,000 bushels worth two billion dollars. Hybrid corn thus in a sense paid for the entire development of the atomic bomb. Even more important, it was a large factor in preventing this time the aftermath of hunger that followed the end of the first World War; for the amount of food we were able to ship to the desolated countries of Europe in 1946–47 was more than equalled by the increase in the corn crop attributable to the planting of hybrid corn. The hunger and chaos of Eastern Europe in 1918 and 1919 furnished Communism with the seedbed in which it first rose to political domination in Russia. The curbing of the spread of Communism in Western Europe after the more recent World War may in a very considerable measure have been due to the boon of hybrid corn, as Paul Mangeldorf of Harvard University has claimed.

It is of some interest, therefore, to see just what G. H. Shull did with his corn plants. He started out with the intention of studying the inheritance of quantitative characters, such as yield, in order to see whether these followed the laws of Mendelian inheritance; and he began by inbreeding his lines. He found that this inbreeding brought out a number of hidden, deleterious hereditary characteristics, and that the inbred strains showed a marked loss of both vigor and productiveness. Eventually he obtained very pure strains of great uniformity, though from the point of a farmer totally worthless, runty, and weak, with small ears bearing few seeds, and of course very low in yield. When, however, two of these inbred lines were crossed together, there was a phenomenal improvement in the hybrids. The ears were large and full, and the production equalled or bettered that of the best strains of the time.

In 1917 Donald F. Jones, at the Connecticut Agricultural Experiment Station, invented the so-called "double cross," with quite the opposite effect from that of the usual connotation. By crossing together the two hybrids produced from the single crosses of four different inbred lines, A, B, C, and D, Jones obtained seed that, when planted, considerably exceeded in vigor and yield even the hybrids of the first crosses, of A with B, and of C with D. Seed produced by Jones' method is the present-day hybrid corn, and later efforts have been devoted simply to finding the best inbred lines to combine for a particular purpose or area, and to producing the hybrid seed in a quantity

Continued on the next page

We are on the verge of revolutionary, and potentially devastating, biological discoveries. We will need great wisdom to control them

GENETICS IN THE SERVICE OF MAN

Continued

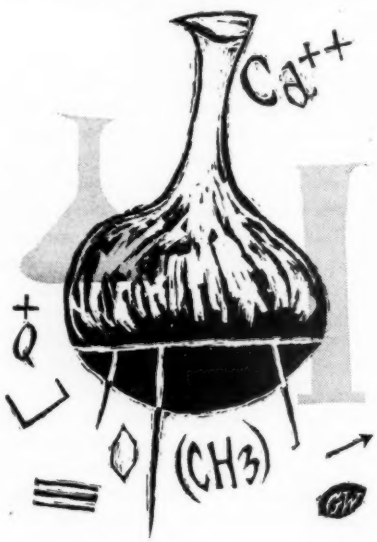
great enough to plant some sixty million acres.

The same hybrid corn that is best suited for growth in Iowa is not adapted to Texas, and assuredly not to Mexico. Hence the extension of the benefits of hybrid corn to the entire nation, and then to foreign countries, requires a repetition of the process while utilizing native strains of maize. This takes time, but requires no essential modification of theory or method. Already in Mexico hybrid corn suited to the country has been produced and is revolutionizing the agriculture of that country, and with it the level of well-being and the culture of the people, which from pre-Conquest days has been based on maize. When we realize that today two-thirds of the world's population are chronically malnourished, and that larger and larger populations are inevitable before the world population can be stabilized, the importance of hybrid corn and similar products of the geneticist's plant breeding becomes fully evident.

Eventually we may have to subsist on great quantities of yeast or some microscopic alga like *Chlorella* that can be raised by the ton in tanks of nutrient solution, but these answers to the world's hunger are not yet ready. Meanwhile the geneticist must continue to breed drought-resistant sorghums, new wheat varieties that are resistant to the latest mutant forms of wheat rust, and more productive fruits, vegetables, and field crops like hybrid corn. Even when the day of mass-produced yeast and algae does arrive, the geneticist will have had to make an essential contribution in finding palatable, productive, and disease-resistant strains, as the British learned during World War II. For after many millions of dollars had been spent in producing a great yeast plant in Trinidad, which was to run on waste molasses and feed cheaply the teeming populations of the Caribbean, it was found that the natives didn't like it and wouldn't eat it, regardless of how nutritious it was said to be.

The geneticist faces such responsibilities with modest confidence, for within the past fifty years his knowledge of reproductive processes and hereditary mechanisms, of the nature of genetic changes within populations, and of evolutionary processes on a still larger scale has so increased as to enable him at will to alter the hereditary nature of any plant or animal in an astonishing variety of directions. He can even create new species—in fact, he has already done so. He can, in short, control the course of evolution.

The evolutionary process is conceived today in somewhat different terms from those of Charles Darwin, although his ideas have been supplemented rather



than superseded. In a population that is breeding quite at random with respect to certain alternative characteristics, the gene frequencies underlying those characteristics will remain in equilibrium, unchanging from generation to generation. In other words, the hereditary nature of the species, the make-up of the population, will change only if some factor upsets the equilibrium and favors one gene over another.

Four major factors contribute to evolutionary change. Only these four, and no others, can be shown to be effective in altering the frequency of particular genes in populations. The first of these factors is mutation, the rare but permanent change of individual genes or chromosomes. This is the process fundamental to all the others, for it provides the variety of hereditary material upon which the other factors can act. The second factor is natural selection, which is today regarded simply as the differential reproduction of genetic types rather than as that ruthless competition embodied in the classic phrase, "the survival of the fittest." The third factor is genetic intermixture, brought about by means of the migration and interbreeding of individuals from populations that have been to some degree isolated in the past and have become genetically differentiated, like the several races of mankind. The fourth factor is chance itself, which in populations of very small size may result in statistical fluctuations about the expected composition of the population. These deviations may sometimes chance to occur in the same direction, like a run of luck, until the hereditary composition of the population is quite altered.

Human control over the mutation process began in 1927 and 1928 when my former teacher H. J. Muller and my later friend and mentor L. J. Stadler, working quite independently, the one with fruitflies and the other with maize and barley, succeeded in demonstrating that exposure to x-rays enormously increases the frequency of all kinds of mutations. Other kinds of potent radiations, and even ultraviolet rays, were found to do the same. During the course of World War II, as a by-product of the scientific study of poison gases, chemical compounds were discovered that likewise enhance the frequency of mutation. Dozens of workers are now actively studying the conditions that limit or enhance the action of physical and chemical mutagens. From all this exploration there is arising the ability—not yet to direct the course of mutation so as to produce just the mutation desired, or even a particular type of mutation, for that is still impossible—but to increase the overall frequency of mutation so that once-rare hereditary changes become common.

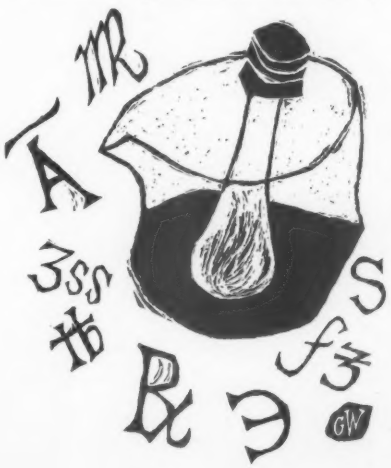
Most of the mutations produced are harmful to their carriers, as might be expected from a blind interference with the delicately balanced mechanisms of life. Most mutants have a lower viability and a poorer fecundity than the types

they are derived from. Yet this is not always so. Sometimes a new mutant type may be poorer than the original type under the existing conditions of life, but may prove itself superior when these are altered. Flies dependent on garbage pails do better in the city of Baltimore if they have wings, but on the storm-swept island of Kerguelen in the southern Indian Ocean the only flies to be found creep about without wings, or with little stubby vestiges of wings. Natural selection, as Darwin pointed out, determines the differential survival of various hereditary types, and natural selection is but a name for the complex combination of conditions under which each population lives and reproduces, and which is different, at least somewhat different, in every other time and place.

For a long time now mankind has substituted for the selection of nature his own artificial selection of whatever chance mutations appeared in his domestic animals and cultivated plants and which seemed to him to be desirable. It is thus that all the progress in plant and animal breeding has been made, from the day the first animal was tamed and the first seed planted to the beginning of our own century. What geneticists are now enabled to do is merely to speed up this process a thousandfold and to control and direct it more effectively. Thus, for example, it was discovered about five years ago that certain inbred strains of field corn have as high a sugar content in the stalk as sugarcane itself. The genetics has been worked out, selection has been used to obtain strains with a constant high sugar content in the stalk, and now hybrid corn with sweet stalks is ready to be used, either for the human sweet tooth or as silage for our horses and cattle, which need sugar too. A shorter corn plant that would stop growing at less than six feet in height would clearly be invaluable to the seed-growers of hybrid corn, who find some difficulty in detasseling, by hand, corn plants that grow twelve feet tall. The desired mutation was found, and now hybrid corn that is just as productive as formerly, but grows to only six feet, is available.

The third evolutionary factor is genetic intermixture, certain possibilities of which have already been indicated in what has been said about hybrid corn. Intermixture may, however, be extended to wider limits, to encompass crosses between different geographic races or even different species. The latter have evolved to a point where the hybrids between them are commonly highly sterile—witness the mule. Yet just here, by an odd chance, there emerges the very mechanism that has enabled the geneticist to create his first true new species. For if in some way the chromosomes of a sterile hybrid can be doubled, its self-fertility is often completely restored, although it remains infertile when crosses are made with either of the parent species. If, for example, one could double the chromosomes of the mule, the latter would have two sets of horse chromosomes and two sets of ass chromosomes. Hybrid sterility is often due to the inability of the chromosomes of different species to pair with one another during the formation of the sex cells; but after doubling, one set of horse chromosomes could pair with the other and likewise for the ass chromosomes, so that each egg cell or each sperm cell would possess when mature a full set for both kinds. No one has yet succeeded in doing this to a mule, or in breeding two mules together afterwards, but exactly this feat has been accomplished a number of times in the plant world.

The first and most famous instance was performed by a Russian geneticist, G. D. Karpechenko, in 1927. Karpechenko crossed two different genera, the radish (*Raphanus*) with the cabbage (*Brassica*), and obtained a sterile hybrid. He then succeeded, with some difficulty, in getting the chromosomes to double, following which he could self-pollinate the hybrid and obtain in the next generation a pertectly fertile form which he named *Raphanobrassica* and which,



according to the same etymological principle, should in English be called by the common name of "rabbage." Since it could be crossed with the original radish or cabbage parent species only with a resultant almost-complete breakdown of fertility, Karpechenko rightly regarded this as a new species, the first man-made one in history.

But unfortunately for Karpechenko, the new rabbage species combined the prickly inedible leaves of the radish with the miserable root of a cabbage. Although he received worldwide fame among geneticists for his feat, it was scarcely an achievement to impress the makers of agricultural five-year plans. Karpechenko was later liquidated. The method is nonetheless one of great promise, for in some instances the valuable characteristics of two species may thus be combined in a single new one; and today, by means of the drug colchicine, it has become easy to double the chromosomes of a hybrid, just the step where Karpechenko met his greatest difficulty.

There is, at any rate, no difficulty in controlling the amount of genetic intermixture by performing, on the one hand, the desired crosses, and on the other by isolating and otherwise preventing intermixture, just as man in the past has controlled the interbreeding between different breeds of dogs or cats. As to the fourth factor, this too is under human control because it depends particularly on the size of population, which may be readily regulated.

At this point one might feel like singing, with Swinburne, "Glory to Man in the highest, for Man is the Master of things." But one had better be wary. Problems aplenty remain just as soon as one begins to consider the application of this newfound genetic power to Man himself.

Eugenics, the term Francis Galton applied to this endeavor, was envisioned by him as the safeguarding and improvement of our human heritage. The late professor W. E. Kellicott of Baltimore defined it as "the social direction of human evolution." This seems to be a very good definition, for it focuses attention on the process as well as the power to control it, on the choice of goals as well as the ultimate chooser. The basis of effective eugenics must include not only an understanding of

Continued on page 12

THE BUILDING OF

COACH AND PLAYERS WORK, PLAY HARD FOR LONG HOURS BEFORE SEASON OPENS

BASKETBALL is a game that requires, in addition to extraordinary stamina on the part of its exponents, not only individual skill, initiative, and imagination in great abundance but also a fine sense of teamwork and an ability to carry it out. To develop these attributes to the point where a team can be declared ready for intercollegiate competition is an exacting process that demands—of coaches and players alike—devotion, long hours, and hard work.

Here is the story of the building of one such team, from the early tryouts for varsity and other squads, through the painstaking drills and the narrowing-down process that takes place on winter afternoons in a gym, to the goal to which it all aims: the year's first game.

In practice garb, four aspirants to this year's team scrimmage under a basket in Hopkins gym.

F A BASKETBALL TEAM

Photographs for The Johns Hopkins Magazine by Robert M. Mottar

Perspiring after an afternoon practice session, a group of players listen to a critique of their workout by the coach.

BASKETBALL TEAM

Continued

Working with four basketballs, a group of nine devotes part of a practice session to incessant ball-passing practice.

SUPERVISION...

In sweatshirt and pants, the varsity coach, Robert Bilgrave, watches from sidelines as his team begins to take real shape.

After watching group in action, Coach Bilgrave counts off on his fingers errors which he feels need special attention.

... AND PRACTICE

Running laps around the gym, players build up "wind" which is highly essential for fast pace that this game requires.

From coach (*top picture*), one player gets advice on technique, tries it out on his own (*center*) and (*right*) with team.

By the time of the first game, the team is ready (***see the next page***).

Keyed up to fine pitch, both teams play hard. Action in center of floor and under both baskets is fast. The score is close.

In locker room before the first game, Coach Bilgrave gives team members a last-minute talk. Then team enters gym.

BASKETBALL TEAM

Continued

FOR OPENING GAME, THE TEAM IS TENSE BUT 'UP'...

Gesturing to a player out of picture at right, referees align men for foul shot.

No. 28 mops head as coach, tight-lipped, cues man at left to go in as substitute.

...and in a stunning rally in closing seconds, Hopkins wins

Genetics In Man's Service

Continued from page 5

evolutionary processes and the power to control them; it must include also a far wider knowledge of human genetics than now exists, and the ultimate consideration by society of many questions of human values.

The idea of the social direction of human evolution is not new. Many people have practiced infanticide in order to rid their society of abnormal or defective individuals. The ancient Spartans not only did this, but also, in order to maintain ascendancy over the helots, they practiced most of the eugenic measures advocated in recent times. Their emigration was restricted, and marriage within their own order was encouraged. Special taxes were levied on celibates, and the production of offspring was rewarded by the state. A severe regimen was maintained to promote fitness and to eliminate the weak or deformed. Also, periodically, the helots were massacred, so as to keep that supposedly inferior element of the population down. Plato's proposals for a eugenic society are likewise famous.

THERE are many misconceptions about heredity. For example, in the strict sense, there are no hereditary *characteristics* at all. The fertilized egg from which each of us starts out in life must *develop* those characteristics common to all members of its species, race, and family, besides those peculiar to itself. One inherits only what is in the fertilized egg: that is, in the physical sense, only the chromosomes and the genes they contain; in the developmental sense, only the potentialities and capacities inherent in those genes. Those potentialities can be realized only within the limitations of the environment.

Heredity is bi-parental; for each gene inherited from one's mother, a corresponding gene is inherited from one's father. These corresponding genes are not a'ways identical, because mutations give rise to varieties of the same gene within the population. Should the two genes of a pair happen to be different (a condition called "heterozygous"), then one gene, known as the dominant, commonly determines the specific trait concerned; and the other gene, the recessive, is masked, although it will still be transmitted to succeeding generations without alteration. Thus a person who has a pair of genes, one for brown hair and the other for red, will have brown hair, and the presence of the gene for red hair may be quite unsuspected. One can have red hair only by inheriting two genes for red hair, one from each parent; one would then be "homozygous." A good many of each person's genes are probably recessive, and most of these will be heterozygous and as a consequence unobservable.

The significance of this for eugenics is unmistakable: a considerable proportion of the genes in any person, and therefore in the entire population, is hidden, and to that extent the measures of eugenics must be applied blindly.

Many characteristics are determined or affected by more than one pair of genes—intelligence, for example. In such a case it is a particular combination of dominant genes, perhaps together with some homozygous recessive genes, that determines the nature of the character. These combinations are very rarely inherited *in toto*, the reason being that no one inherits all his parents' genes, but only half of the genes of each. Pure chance determines which gene of the two making up each pair in the father and the mother will be transmitted to the child. Hence, the more genes there are in a given combination, the lower the chance that that combination will be transmitted intact. Nearly all combinations are broken up as the germ cells mature, and new combinations of a bi-parental origin are formed. Inasmuch as most of the human characteristics which are of social significance depend upon multiple genes, the combinations of which cannot be preserved, whether good or bad, the importance of this reassortment and recombination of genes in heredity to the success of eugenics can scarcely be over-emphasized. Moreover, a particular gene which in most combinations has an adverse effect may, in just the right combination, produce a desirable effect; and conversely, a particular gene that in most combinations has a favorable effect may get into a bad combination. The geneticist can scarcely appraise the absolute, overall effect of a gene; it must be judged by the company it keeps.

GALTON was the first person to try to assess the relative power of heredity and environment in determining a person's characteristics. From his studies of the familial occurrence of genius and special talents, and from comparisons of one-egg and two-egg twins, he was convinced that "the power of nature was far stronger than the power of nurture, when the nurtures of the persons being compared were not exceedingly different." There is no reason to alter this judgment today, although one may amplify it. Thus, in general, physical traits are most rigorously determined by heredity, mental traits are more modifiable by environment, and social traits and personality, although still clearly affected by heredity, are most readily suppressed, diminished, or enhanced by past experience and present environment. A similar hereditary nature, as seen in "identical" twins, generally leads through similar development to similar characteristics, provided the individuals are not subjected to radical differences in their environment.

It is clearly necessary to clarify the meaning of that term "radical" in the present context. A pair of blond one-egg twins may be temporarily separated, one kept indoors, the other sent for a vacation at a beach. In a few weeks one is sunburned and very much darker than his twin. This does not mean that environment determines complexion and that heredity has nothing to do with it. It means that for blonds the amount of sunlight can constitute a "radical" difference of environment. Yet not all characteristics are affected by this particular "radical" difference of environment. It requires careful observation to determine whether a specific difference in environment can affect a characteristic or not, and it must be determined separately for each characteristic. The effects of environment are inextricably interwoven with the effects of the genes in the formation of a person's characteristics.

Only by mutation do new sorts of genes come into existence, and without it there could be no long-continued process of evolutionary change, eugenic or otherwise. The mutation rates for several human genes have been estimated. Their average is about one in fifty thousand per generation; that is, to take a specific example, in a population of fifty thousand persons one person has

Again, to our regret, space limitations force us to omit "A Johns Hopkins Gazette." An expanded "Gazette" section will appear in the **April issue**

a gene for hemophilia which was not inherited from either parent, but instead arose by mutation from a corresponding gene for normal blood clotting. Hence, unless one could somehow prevent mutation to it from occurring, no measures can be successful in eradicating an undesirable gene from the population. At best, its frequency can be reduced to the level of the rate of mutation to it. Hemophilia cannot be eliminated; its lowest limit is set by mutation at a gene frequency of one in fifty thousand.

For eugenics, the induction of mutations by x-rays or chemicals is too potent a tool, since the vast majority of all mutations produce harmful consequences. Hardly one in five hundred or a thousand improve its possessor's fitness in the local environment. Although most mutations are recessive, and consequently do not show up for many generations, until in the course of time they become homozygous, nevertheless it is clearly undesirable to fill the human germplasm with an overload of harmful genes. It is likely, according to several methods of estimation, that even now everyone possesses at least one lethal gene that in a double dose would destroy us. Other detrimental genes are probably about three times as numerous as the lethal genes. These genes persist in the population because they are hidden, each kind being prevented from becoming more common because of natural selection. In the elimination of detrimental genes by natural selection a lot of desirable genes are also lost each time, for selection can act only on individuals; that is to say, on entire combinations of genes. It cannot pick out the solitary gene that is chief offender. The reassortment and recombination of genes that is the chief outcome of sexual reproduction represent salvation here, since they render it unlikely that the same unoffending genes will be lost each time a particular kind of detrimental gene is eliminated.

The rapidity with which the frequency of a harmful gene can be reduced by selection depends upon the percentage of carriers who manifest the effects of that gene. A full dominant, for example, with a fitness of only half normal, would in twenty generations, or about 550 years, be reduced to one-millionth of its original frequency. It would almost certainly before that time reach the level where it would be maintained by fresh mutation. Consequently, any particular harmful dominant trait is already, because of natural selection, very rare. It is of no eugenic consequence to try to deal with them. Only special circumstances, like the failure to manifest themselves until late in life, bring a few dominant traits, such as Huntington's chorea, a very unfortunate nervous affliction commonly known as St. Vitus' Dance, within the scope of eugenic measures.

On the other hand, a recessive with a fitness of one-half normal would in twenty generations be reduced by only forty percent. What is more, the amount of reduction declines in each successive generation, as the proportion of heterozygous, concealed genes becomes larger and larger. The frequency of a *common* recessive gene, like those for blue eyes or red hair, might therefore be reduced by special measures very quickly; but the reduction in frequency of a gene that is already rare is almost imperceptible. Since natural selection has already been at work for ages past, no gene very detrimental to viability or fertility can have become common. Each sort of harmful gene is already rare in frequency and is maintained in equilibrium between mutation and selection. The combinations of genes which determine complex traits such as intelligence are even more slowly affected by selection.

Chance changes in gene frequencies are not of as great eugenic significance in modern times as formerly, for they occur significantly only in small populations, such as the hunting groups of prehistoric man or the isolated rural communities of medieval times. In a study my colleagues Milton Sacks, Elsa Jahn, Charles Hess, and I recently made of a Dunker community in Franklin County, Pennsylvania, we found clear evidence that the genetic composition of such a group can deviate radically and within a span of three generations from its original make-up as well as from that of the surrounding population. In such communities even harmful genes might become established by chance; or even a beneficial gene might be eliminated. Furthermore, in a small population there is of necessity a closer degree of relationship between those who marry. This inbreeding does not of itself change gene frequencies, but it brings the recessive genes out into the open and allows selection to be exercised upon them. If a line is free of harmful recessive genes, this inbreeding will do no harm. (Cleopatra herself came of a number of generations of brother-and-sister marriages.) But I have already pointed out that most individuals do carry harmful genes. Hence the effect of inbreeding is in general to increase the number of afflicted persons in the population. Actually, since medieval times, the trend has been in quite the opposite direction. This brings us to genetic intermixture.

Obviously the trend of the modern world is away from the isolating effects of religion, race, and geography, even though not so obviously from those of politics. Little populations have been merging to make large ones, and migrations of tremendous magnitude have produced human melting pots the world around. This has had the effect of making a greater proportion of the recessive genes disappear from view and from exposure to selection. They can now increase under cover to a much higher frequency, until such time as by random mating homozygous persons are produced and selection again becomes active upon these genes. The action of the melting pot and the slowness of assimilation are clearly evident in a study of the present-day American Negro made by C. C. Li and myself. On the basis of the frequencies of certain blood groups and other genetic traits in the West African Negroes, the North American Negroes, and the North American whites, it was possible to conclude that the genes of the American Negro are now just over thirty percent derived from the white population, and that at the average rate of past gene flow from the white into the Negro population, it will take approximately two thousand years before assimilation becomes complete. Of course, the process will undoubtedly accelerate as the two populations become less distinguishable, and the gene flow from the Negro into the white population, till now negligible in amount, will some day become appreciable. Meanwhile, it is important to realize what a disastrous increase in the proportion of hereditarily afflicted persons would result if our present populations were for any reason—say, as the aftermath of another world war—to be broken up again into small units.

By surrounding himself with a social environment, mankind has unwittingly modified the rigor of natural selection in many ways. The price we must pay, in the end, for the mercies of medical care

Continued on page 14

"IF YOU DON'T SEE IT, ask for it," is the traditional sign of the storekeeper, which, thank heavens, only a few flippant and less warmhearted emporia have modified to read, "If you don't see it, keep quiet; we ain't got." The Hopkins Bookstore definitely subscribes to the first of these mottoes. If, when you are browsing through our stocks of books, you don't find the volume you are looking for, *ask* us. If we don't have it in our stockrooms, we will be delighted to get it for you.

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Genetics In Man's Service

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and surgical aid is the dysgenic increase in the frequencies of certain detrimental genes whose effects we have learned to ameliorate. Thousands upon thousands of diabetics who in a former day would have died early in life are now saved by insulin to live relatively normal lives, and, of course, to pass on the gene responsible for their diabetes to their descendents. Myopia is no longer a grave handicap in life; hearing aids alleviate certain types of deafness. Probably no one would have it otherwise. Yet to contemplate a future population composed largely of persons who must wear both glasses and hearing aids, and must start the day by inserting their false teeth and taking first an insulin injection in one arm and then allergy shots in the other, is none too pleasant. To say the least, medical science is steadily increasing the load it must carry.

Another instance of the unconscious direction of human evolution lies in the differential reproduction of economic and cultural groups. The differential reproduction of the several races may be passed over, since there is no valid evidence that any known hereditary differences between races alter viability or fertility, or affect any eugenic desideratum, such as intelligence. But there is little doubt that there is some positive correlation between intelligence and economic and cultural level, in such countries as the United States and Great Britain. In these countries the reproductive rate varies inversely with income. Theoretically, this should result in a decrease of those genes contributing to high intelligence, although the decrease may be slow. Yet the only extensive study on the subject, that of the I.Q.'s of virtually all Scottish school children over a fifteen-year period, 1932 and again in 1947, has revealed no decline whatsoever.

THE various measures of positive and negative eugenics may now be considered. The former comprises four methods, all in use in certain states or countries.

The method most widely used is that of segregating males and females in separate institutions, such as prisons, mental hospitals, or "homes." This type

of measure is quite effective in preventing the propagation of the inmates. However, most social institutions of these kinds are today regarded as having a curative function rather than one of permanent incarceration or care, and eventually a large proportion of the inmates are released and are again at liberty to reproduce. To take care of the feebleminded alone in such institutions would require an enormous increase in the number of institutions and the amount of care beyond what is at present available, since it is estimated that from one to three percent of the entire population, or some five million persons, in the United States, are feebleminded.

A second method is that of sterilization. This is also highly effective for the purpose. The surgical methods now used consist of ligating or cutting the sexual ducts, a method which prevents reproduction without interfering with the hormonal secretions of the ovaries or testes and thereby causing changes in the sexual characteristics and emotions, as castration does. In the United States, twenty-seven states have laws for the sterilization of the hopelessly insane or the feebleminded, but application varies greatly. The total of sterilized persons now amounts to more than fifty thousand, of whom about half were insane and half feebleminded. By the most rigorous program of sterilization and segregation, mental defect and disease could be reduced perhaps fifteen percent; that is, from two percent of the population to 1.7 percent. This may well be worth doing, but it is certainly far from elimination, which is apparently the expectation of many uninformed eugenists.

A third method consists of the universal encouragement of birth control by providing free birth-control clinics and supplies. Since birth control at present obtains largely in the higher social and economic groups, the extension of birth control to all classes of the population would, it is argued, tend to restore the balance between the differential reproductive rates of the more intelligent and the less intelligent. Probably to some extent this is true, and in Sweden, where this measure has been carried out, it seems indeed to have brought the reproductive rates of all economic classes of the population into line. However, even to use the present methods of birth control requires considerable intelligence, so that only too probably this measure will

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Genetics In Man's Service

Continued from page 15

lower the reproductive rate of the intelligent persons of *all* economic and social classes, but will affect that of the morons and feebleminded much less. Note also that most methods of birth control are vigorously condemned by certain religious groups, although in India the objections appear to be weakening.

The final negative measure is one which does not actually change gene frequency but only diminishes the proportion of individuals who manifest certain traits. This measure is the prohibition of consanguineous and assortative marriages. In nearly all societies, taboos or legal restrictions have long existed against the closest degrees of in-marriage. Perhaps these grew up because it was commonly observed that such marriages often yielded abnormal or defective children. At any rate, the only practicable extension of this method would be to prohibit marriages of first cousins, wherever now allowed. This would stop only about fifty-six percent of all consanguineous mating, according to J. B. S. Haldane, and in Baltimore, according to my own data from the Baltimore Rh Laboratory, would prohibit only five marriages in ten thousand. By prohibiting assortative mating between defectives, the frequency of such defects as are recessive might more readily be reduced. Thus, assortative mating is strongest among the deaf, and at least two kinds of deafness are inherited as simple recessives. A ban on marriage between deaf persons would considerably reduce hereditary deafness in the population. Against this social advantage would have to be weighed the counter-advantage of permitting a happy social adjustment among the married deaf.

POSITIVE eugenic measures might be of two types. The more extreme is the extensive use of carefully selected sires by artificial insemination, as in animal breeding. It is already possible not only to transport selected semen from one continent to another by air, and to inseminate large numbers of females with it, but also to quick-freeze semen, hold it indefinitely at low temperatures, and thaw it out without depriving it of fertilizing power. The use that thus might be made of the semen of a select male is not only worldwide but might conceivably extend over several centuries of time.

Apart from whatever social repugnance such a method would encounter, it involves a biological outcome that invites disaster. The gene-sharing it promotes in the breed leads to uniformity. In animal breeding this may be obviated by developing a number of individually uniform, but distinct, breeds. For mankind, it is at least arguable that general genetic diversity is better than uniformity. In particular, because of the high frequency of lethal and other harmful recessive genes in the population, there is a grave danger that any widely used sire might spread a detrimental gene throughout the population before it was detected. This has actually happened in cattle breeding.

The other way to promote a higher reproductive rate of the bearers of desirable genes is to offer inducements and rewards for parenthood, and to remove impediments to it. Such measures already have been tried by many countries concerned about their decline in population, rather than for any eugenic reason. Obviously, the low reproductive rate of the more intelligent people is mainly a result of choice. Too clearly they see that each added child is an economic burden that diminishes the standard of living of the entire family and the opportunities open to the other children. As H. J. Muller once said: "It is undeniable that the profit system leaves little place for children. In general, they are not profitable investments: their cost is excessive, the dividends from them are uncertain, they are likely to depreciate in value, are practically non-transferable, and they do not mature soon enough."

What should be done? Direct subsidies to parents have not worked very well in those countries that have tried them. Taxation more steeply graduated in inverse ratio to family size, and the multiplication of social services rendered directly to children, or to expectant or nursing mothers, seem to provide one answer.

EUGENICS, although based on the science of genetics, is not itself a science, for it must above all concern itself with social values, with the question, Whither mankind? Perhaps general agreement could be reached that freedom from gross physical or mental defects, sound health, high intelligence, general adaptability, integrity of character, and nobility of spirit are the major goals toward which eugenics should aim; perhaps too that diversity of nature is better than uniformity of type. But how far ought selective reproduction to interfere with human freedom? Genetically, as in other respects, "there is so much bad in the best of us and so much good in the worst of us" that it is hard to assess the worth of the manifest hereditary characteristics of a person; and the numerous hidden genes make it quite impossible.

Nor can anyone determine to what extent a person's manifest characteristics are the product of environment, particularly as to those qualities that are eugenics' major concern—sound health, high intelligence, and the like. The Jukes and Kallikaks were horrible examples of degenerate humanity, but what might they have been in a better world? Was their alcoholism, their crime, their vice an inescapable product of their genes? It seems very doubtful Only the experiment of putting them from earliest infancy into an optimum environment could possibly yield an answer.

It will be easier to define the essentials of an optimum environment—not forgetting that it need not be alike for everyone—than to modify gene frequencies by wise selection. Once mankind has produced an approximation of that optimum environment, the eugenic task will be simpler. In fact, the natural selection exerted by such an environment may make other eugenics quite unnecessary.

THE moral is very plain. Today man, in the shape of the geneticist as well as in the shape of the physicist, possesses more power than wisdom. He could, as I have said elsewhere, "crystallize human society into a changeless rigidity dominated by reason armed with infinite scientific knowledge." He might even breed "a ruling caste of a relatively few individuals, evolving higher and higher levels of intelligence, and a helot or robot caste of workers, chained by their instincts and minimal intelligence to the performance of simple, mechanical tasks." But can the geneticist breed wisdom, or integrity, or even simple humanity? As a former instructor in this University once wrote, in an inimitable essay on the same subject, "If we are to make a better world, we must breed people like Palamedes; the danger is that we shall breed people like Odysseus instead."

At Johns Hopkins

COMMEMORATION DAY—The seventy-ninth anniversary of the University's founding will be marked at formal exercises, at which Wilson H. Elkins, president of the University of Maryland, will deliver the principal address. Honorary degrees will be presented to Dr. Elkins, to Samuel J. Crowe, professor emeritus of laryngology and otology at Johns Hopkins, and to Millicent Carey McIntosh, president of Barnard College of Columbia University (Tuesday, Feb. 22 at 11 a.m. in Shriver Hall).

UNIVERSITY LECTURE—John C. Whitehorn, professor of psychiatry, will speak on "Stress and Emotional Health" in a lecture that is open to the public without charge (Wednesday, Feb. 9 at 4:15 p.m. in Shriver Hall).

VARSITY SPORTS

BASKETBALL—Johns Hopkins vs. WASHINGTON COLLEGE on Saturday, Jan. 22 (away); RUTGERS on Tuesday, Feb. 8 (away); LOYOLA on Thursday, Feb. 10 (Homewood gymnasium at 8:45 p.m.); WESTERN MARYLAND on Saturday, Feb. 12 (away); CATHOLIC on Wednesday, Feb. 16 (away); HAMPDEN-SYDNEY on Saturday, Feb. 19 (Homewood gymnasium at 8:45 p.m.); LOYOLA on Wednesday, Feb. 23 (away); WESTERN MARYLAND on Saturday, Feb. 26 (Homewood gymnasium at 8:45 p.m.). The MASON-DIXON TOURNAMENT will be held on Thursday, Friday, and Saturday, March 3, 4, and 5.

FENCING—Johns Hopkins vs. ILLINOIS on Friday, Feb. 4 (Homewood at 2 p.m.); TEMPLE on Saturday, Feb. 12 (away); PENNSYLVANIA on Saturday, Feb. 19 (Homewood at 2 p.m.); HAVERFORD on Saturday, Feb. 26 (away).

WRESTLING—Johns Hopkins vs. TOWSON TEACHERS on Saturday, Feb. 5 (Homewood gymnasium at 8 p.m.); SWARTHMORE on Friday, Feb. 11 (Homewood gymnasium, time to be announced); DELAWARE on Tuesday, Feb. 15 (away); LOYOLA on Saturday, Feb. 19 (away). The MASON-DIXON TOURNAMENT will be held on Friday and Saturday, Feb. 25 and 26, at Towson State Teachers College, Towson, Md.

THE JOHNS HOPKINS ALUMNI ASSOCIATION—The annual dinner will be held on Commemoration Day (Tuesday, Feb. 22 at 6 p.m. at the Sheraton Belvedere Hotel, Baltimore).

THE JOHNS HOPKINS MEDICAL AND SURGICAL ASSOCIATION—The biennial meeting will be held in Baltimore on Friday and Saturday, Feb. 25 and 26, with several supplementary events occurring on Thursday, Feb. 24. It should be noted that the following listings are based on a tentative schedule and should be checked for last-minute changes: THURSDAY, FEB. 24—Dinner of former residents in general surgery (6:30 p.m. at the Maryland Club); dinner of former residents in gynecology (7 p.m. at the Elkridge Club); dinner in honor of Leo Kanner's twenty-fifth anniversary in child psychiatry (7 p.m. at the Sheraton Belvedere Hotel). FRIDAY, FEB. 25—Operative clinics, ward rounds, open houses, clinical programs, discussions (throughout the morning in various departments); luncheon (1 p.m. at the Welch Medical Library); additional open houses, seminars, clinical programs (throughout the afternoon); tea and business meeting for women alumnae (4:30 p.m. at 800 North Broadway); reception (6:30 p.m. at the Lord Baltimore Hotel, mezzanine); reunion, classes of '04 and '05 (6:30 p.m. at the Lord Baltimore Hotel, parlor M); reunion, class of '29 (6:30 p.m. at the Lord Baltimore Hotel, Carnival Room); reunion, class of '30 (6:30 p.m. at 14 West Hamilton Street Club); dinner: speakers, Philip Bard, dean of the School of Medicine, and Walter B. Martin, president of the American Medical Association (7:30 p.m. at the Lord Baltimore Hotel). SATURDAY, FEB. 26—Business meeting (10 a.m. at Hurd Hall); ward rounds, clinical programs, discussions (throughout the morning); luncheon (1 p.m. in the Hospital dining room); dinner of former residents in otolaryngology (7 p.m. at the Maryland Club).

WASHINGTON ALUMNI—The annual dinner will be held in February; for details, telephone William K. Norwood at WOodley 6-2343 in Washington.

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